With GaN HEMT,
Power Factor Correction 240 W 400 V
BM3G007MUV-EVK-002

User's Guide

＜High Voltage Safety Precautions＞

◇ Read all safety precautions before use

Please note that this document covers only the BM3G007MUV evaluation board (BM3G007MUV-EVK-002) and its functions. For additional information, please refer to the datasheet.

To ensure safe operation, please carefully read all precautions before handling the evaluation board

Depending on the configuration of the board and voltages used,

Potentially lethal voltages may be generated.

Therefore, please make sure to read and observe all safety precautions described in the red box below.

Before Use

[1] Verify that the parts/components are not damaged or missing (i.e. due to the drops).
[2] Check that there are no conductive foreign objects on the board.
[3] Be careful when performing soldering on the module and/or evaluation board to ensure that solder splash does not occur.
[4] Check that there is no condensation or water droplets on the circuit board.

During Use

[5] Be careful to not allow conductive objects to come into contact with the board.
[6] **Brief accidental contact or even bringing your hand close to the board may result in discharge and lead to severe injury or death.**

Therefore, DO NOT touch the board with your bare hands or bring them too close to the board.
In addition, as mentioned above please exercise extreme caution when using conductive tools such as tweezers and screwdrivers.

[7] If used under conditions beyond its rated voltage, it may cause defects such as short-circuit or, depending on the circumstances, explosion or other permanent damages.
[8] Be sure to wear insulated gloves when handling is required during operation.

After Use

[9] The ROHM Evaluation Board contains the circuits which store the high voltage. Since it stores the charges even after the connected power circuits are cut, please discharge the electricity after using it, and please deal with it after confirming such electric discharge.
[10] Protect against electric shocks by wearing insulated gloves when handling.

This evaluation board is intended for use only in research and development facilities and should by handled **only by qualified personnel familiar with all safety and operating procedures.**
We recommend carrying out operation in a safe environment that includes the use of high voltage signage at all entrances, safety interlocks, and protective glasses.

PFC (power Factor Correction) IC

With GaN HEMT, Power Factor Correction 240 W 400 V BM3G007MUV Reference Board

BM3G007MUV-EVK-002

The BM3G007MUV-EVK-002 reference board outputs 400 V voltage from the input of 90 Vac to 264 Vac.

The output current supplies up to 0.6 A.

BM3G007MUV has a built-in GaN HEMT (650V 70 mΩ), driver and protection circuit.

By using this GaN Power Stage, we achieved a maximum efficiency of 97.8%.

The BD7695FJ which is BCM method PFC controller IC is used.

The BD7695FJ supplies the system which is suitable for all of products that requires PFC.

BCM is used for PFC part, and Zero Current Detection reduces both switching loss and noise.

THD is 8.4 % typical.

Electronics Characteristics

This is a typical value and not a guarantee of characteristics.

Unless otherwise noted; V_{IN} = 230 Vac, I_{OUT} = 0.6 A, Ta = 25 °C

Parameter		Min	Typ	Max	Units	Conditions
Input Voltage Range	V_{IN}	90	230	264	Vac	
Input Frequency	f_{LINE}	47	50/60	63	Hz	
Output Voltage	V_{OUT}	376	395	415	V	
Maximam Output Power	P_{OUT}	-	-	240	W	I_{OUT} = 0.6 A
Output Current Range*(Note 1)*	I_{OUT}	0.0	-	0.6	A	
Total Harmonic Distortion(THD)	THD		8.4	-	%	
PF(Power Factor)	PF	0.93	0.97	-	-	AC230 V I_{OUT} = 0.6 A
Efficiency	η	94	97.8	-	%	
Output Ripple Voltage*(Note 2)*	V_R	-	10.4	20	Vpp	AC90 V I_{OUT} = 0.6 A
Hold Time	T_{HOLD}	20			ms	V_{OUT} min 280 V
Operating Temperature Range	T_{OP}	-10	+25	+55	°C	

(Note 1) Cool the component surface temperature with FAN, etc., if necessary, and the load application time so that the temperature does not exceed 105 ℃.

(Note 2) Not include spike noise

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Operation Procedure

1. Operation Equipment

1. AC power supply 90 to 264 Vac, over 1000 W
2. Electronic load capacity 0.6 A which supports input voltage 500 V
3. Multi meter
4. Power meter

2. Connect Method

1. AC power supply presetting range 90 to 264 Vac, Output switch is OFF.
2. Electronic load setting under 0.6 A, Load switch is OFF.
3. The reference board connects to measuring equipments and power supplies as in Figure. 1.
4. AC power supply switch is ON.
5. Check that output voltage is 400 V.
6. Electronic load switch is ON.
7. Operate with enough caution against electric shock because of non-isolated output voltage 400 V.

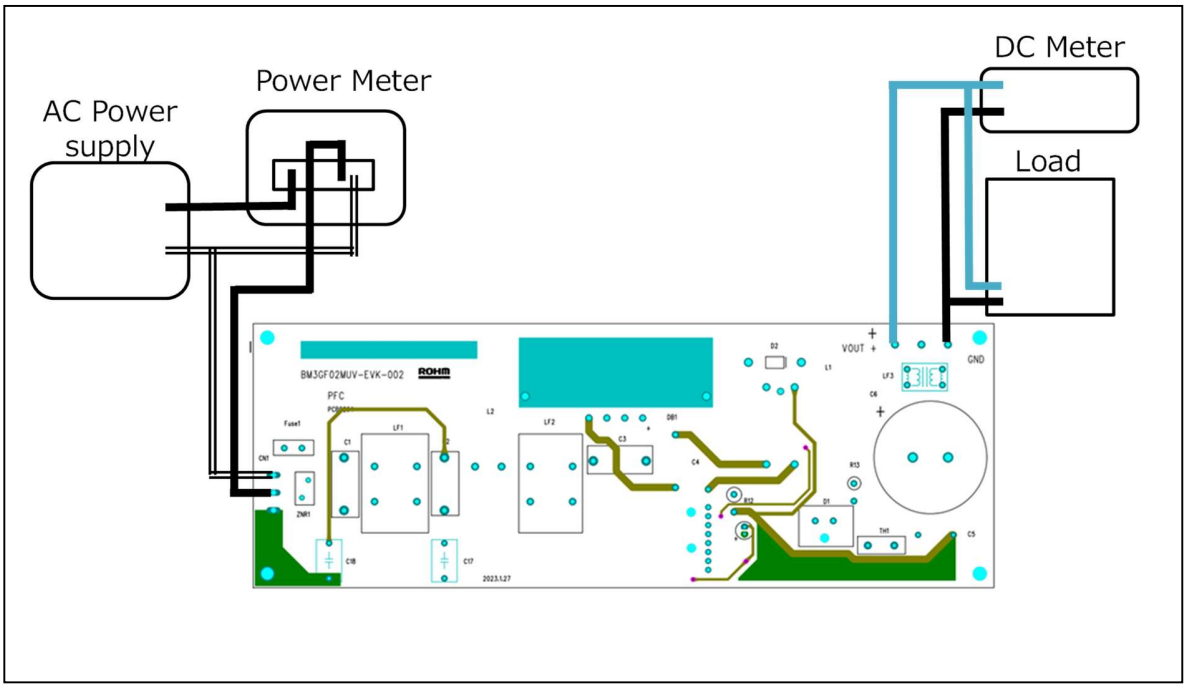


Figure 1. Connection Circuit

Derating

Maximum output power Po of the reference board is 240 W. The derating curve is shown in Figure. 2.

If ambient temperature is over 25 °C, Consider the load current time and air-cool with FAN so that the component surface temperature does not exceed 105 ℃.

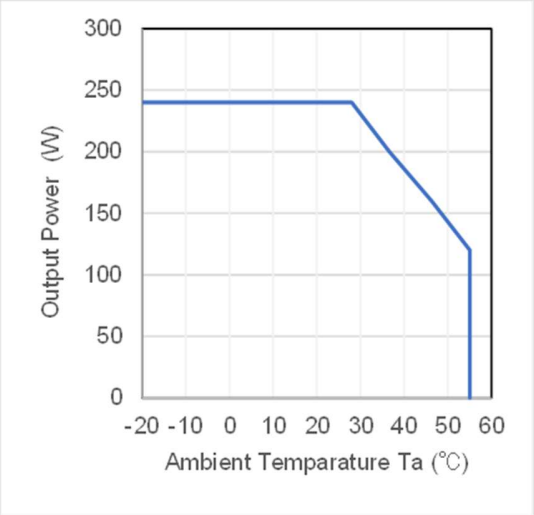


Figure 2. Temperature derating curve

Schematics

V_{IN} = 90 to 264 Vac, V_{OUT} = 400 V

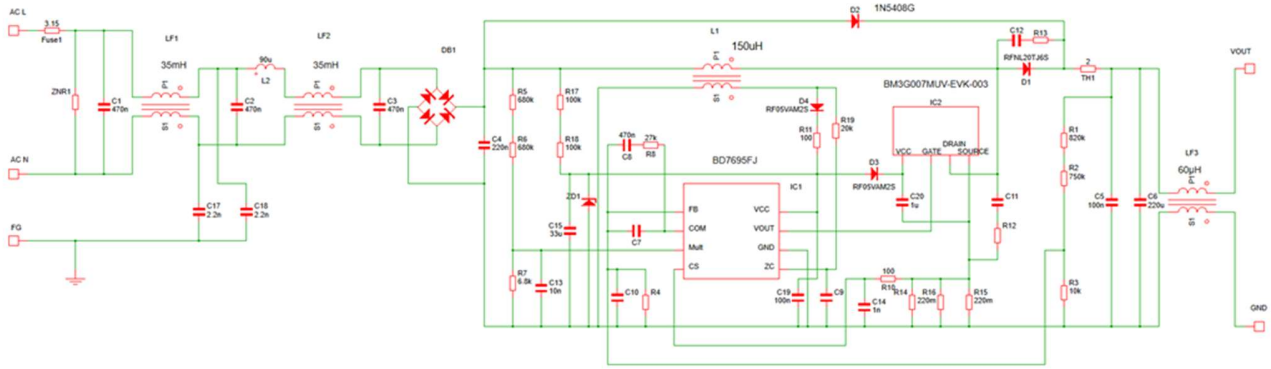


Figure 3. BM3G007MUV-EVK-002 Schematics

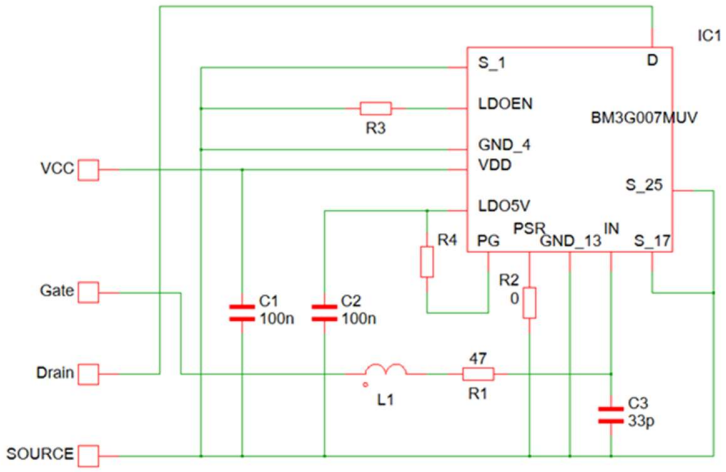


Figure 4. BM3G007MUV-EVK-003 Schematics

Bill of Materials

BM3G007MUV-EVK-002

Item	Specification	Parts Name	Manufacurer
C1,C2,C3	470 nF, 310 Vac	890334025039CS	WURTH ELECTRONIK
C4	0.22 µF, 310 Vac	890334023027CS	WURTH ELECTRONIK
C5	0.1 µF, 630 Vdc	890324023023CS	WURTH ELECTRONIK
C6	220 µF, 450 V	861021486029	WURTH ELECTRONIK
C8	0.47uF	UMK212BJ474KG-T	TAIYO YUDEN
C13	10 nF,50 V	885012206089	WURTH ELECTRONIK
C14	1nF,50 V	HMK107B7102KA-T	TAIYO YUDEN
C15	33 µF, 50 V	860020672012	WURTH ELECTRONIK
C17,C18	2200 pF, Y1:300 Vac	DE1E3RA222MA4BP01F	MURATA
C19	0.1 µF,50 V	GRM188R72A104KA35D	MURATA
C20	1uF / 35V	GMK212BJ105KG-T	TAIYO YUDEN
C7,C9,C10,C11,C12	—	NON-MOUNDTED	
CN1	3pin	B03P-NV(LF)(SN)	JST
CN2	3pin	6.91138E+11	WURTH ELECTRONIK
D1	FRD,20 A, 600 V	RFNL20TJ6S	ROHM
D2	3 A, 1k V	1N5408G	Onsemi
D3、D4	FRD, 0.5 A, 200 V	RF05VAM2S	ROHM
DB1	600 V	GBUE2560-M3/P	VISHAY
F1	310 Vac, 3.15 A	36913150000	LITTLE
L1	150 µH 12 A	750345199	WURTH ELECTRONIK
L2	90 µH	7447013	WURTH ELECTRONIK
LF1、LF2	35 mH/ 3.5 A	7448040435	WURTH ELECTRONIK
LF3	60 µH	LF1246Y	ALPFATRANS
HEATSHINK1	8.3℃/W	20PBE55-25B	MARUSAN
HEATSHINK2	14 ℃/W	E2A-T220-38E	OHMITE
HEATSHINK3	32.7 k/W	OSH-1525-SFL	SANKYO THRMOTECH
IC1		BD7695FJ	ROHM
IC2		BM3G007MUV-EVK-003	ROHM
R1	820 kΩ	KTR18EZPF8203	ROHM
R2	750 kΩ	KTR18EZPF7503	ROHM
R3	10 kΩ	MCR03EZPFX1002	ROHM
R5,R6	680 kΩ	KTR18EZPJ684	ROHM
R7	6.8 kΩ	MCR03EZPJ682	ROHM
R8	27kΩ	MCR03EZPJ273	ROHM
R10,R11	100 Ω	MCR18EZPJ101	ROHM
R15、R16	220 mΩ	LTR50UZPFLR220	ROHM
R17,R18	100 kΩ	ESR18EZPJ104	ROHM
R19	20 kΩ	ESR18EZPJ203	ROHM
R4,R12,R13,R14	-	NON-MOUNDTED	
TH1	2 Ω, 4 A	2D2-13LD	SEMITEC
ZD1	24V	TFZV24B	ROHM
SCREW1,SCREW2		P-4 3MC 3×8	
PCB		PCB0257E	

Materials may be changed without notifying.

Bill of Materials

BM3G007MUV-EVK-003

Item	Specification	Parts Name	Manufacurer
C1,C2	0.1 µF,50 V	GRM188R72A104KA35D	MURATA
C3	33 pF,50 V	GRM1882C1H330JA01#	MURATA
IC1	Rdson 70 mΩ,650 V	BM3G007MUV	ROHM
L1	600 Ω	BLM18AG601SN1D	MURATA
R1	47 Ω	MCR03EZPJ470	ROHM
R2	0 Ω	MCR03EZPJ000	ROHM
R3,R4	-	NON-MOUNTED	
TP1,TP2,TP3,TP4		CK-1-2	MAC8
PCB		PCB0275D	

Materials may be changed without notifying.

PCB

BM3G007MUV-EVK-002

Size: 210 mm x 75 mm

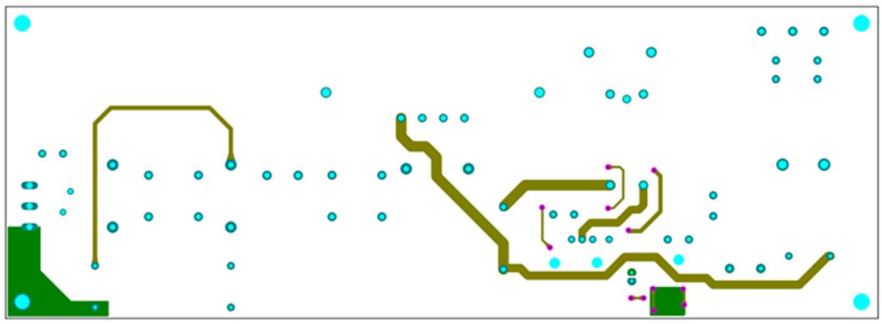


Figure 5. Top Layout (Top view)

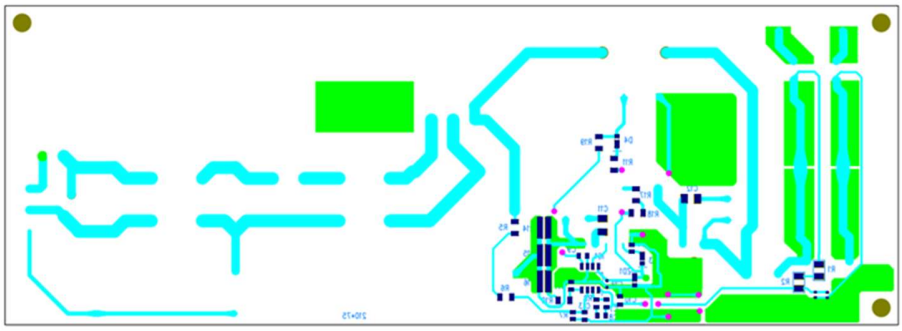


Figure 6. Bottom Layout (Top view)

BM3G007MUV-EVK-003

Size: 19 mm X 22 mm

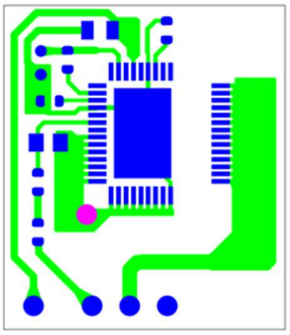


Figure 7. TOP Layout (Top view)

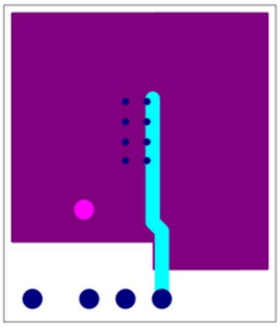


Figure8. Bottom Layout (Top view)

BM3G007MUV Overview

Feature

- Wide Operating Range for VDD Pin Voltage
- Wide Operating Range for IN Pin Voltage
- Low VDD Quiescent and Operating Current
- High dv/dt Immunity
- Adjustable Gate Drive Strength
- Power Good Signal Output
- VDD UVLO Protection
- Thermal Shutdown Protection

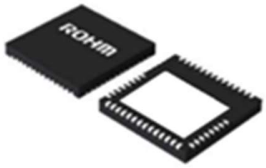
Key Specification

- Operating Power Supply Voltage Range
  VDD pin: 6.25 V to 30 V
  D pin: 650 V(Max)
  IN pin: -0.6 V to 30 V
- Allowable Input Switching Frequency:2 MHz (Max)
  Circuit Current 0.58 mA (Typ.)
- Turn-on Delay Time: 12 ns (Typ)
- Turn-off Delay Time: 15 ns (Typ)
- Operating Temperature Range -40 °C to +105 °C
- GaN HEMT D-S ON State Resistance: 70 mΩ (Typ)

Package **W(Typ) x D(Typ) x H(Max)**

VQ46TV80AW 8.0 mm x 8.0 mm x 1.0 mm

Pitch 0.5 mm



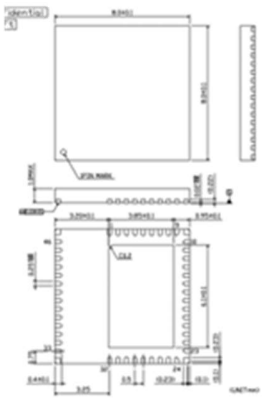


Figure 9. Pin Configuration

Table 1. BM3G007MUV PIN description

Pin No.	Pin Name	I/O	Function
1,2,17-22,24-32,EXP	S	O	GaN HEMT SOURCE pin
3	LDOEN	I	LDO function enable/disable pin
4,13	GND	O	GND pin
5,7,9,19,14,16,23,24	N.C	-	Non-connection
6	VDD	I	Power supply input pin
8	LDO5V	O	5 V LDO output pin
11	PG	O	Power good signal output pin
12	RSR	I	Gate drive strength adjustment pin
15	IN	I	Non-inverting gate drive input
33-46	D	I	GaN HEMT DRAIN pin
	EXP	O	GaN HEMT SOURCE pin
	C.S	-	Corner pin
	C.N.C	-	Cornaer pin, non-connection

Performance Data

Load Regulation

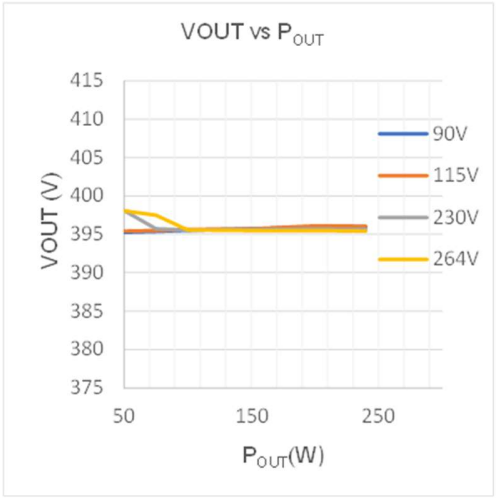


Figure 10. Load Regulation (V_{OUT} vs P_{OUT})

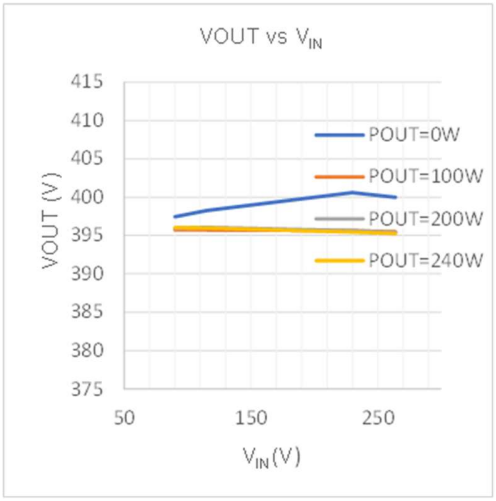


Figure 11. Line Regulation (V_{OUT} vs V_{IN})

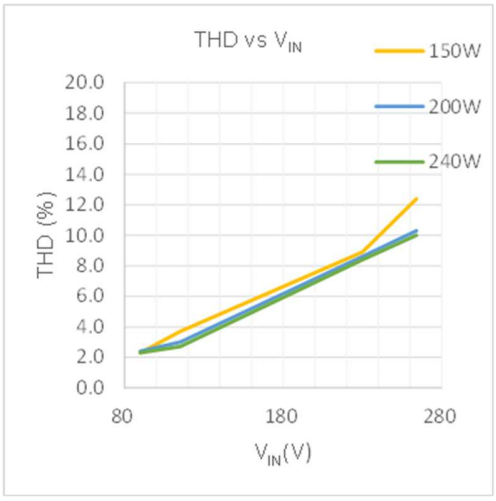


Figure 12. Total Harmonic Distortion (THD vs V_{IN})

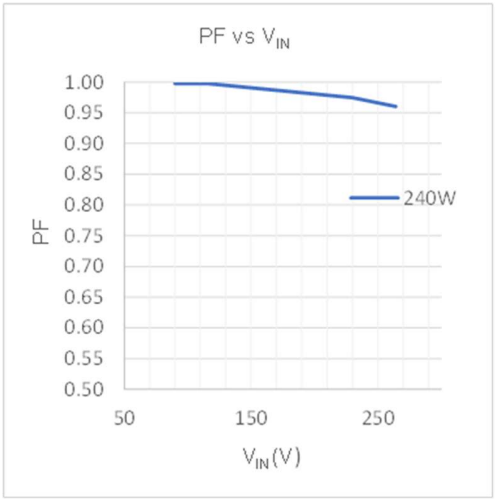


Figure 13. Power Factor (PF vs V_{IN})

Performance data – Continued

Efficiency

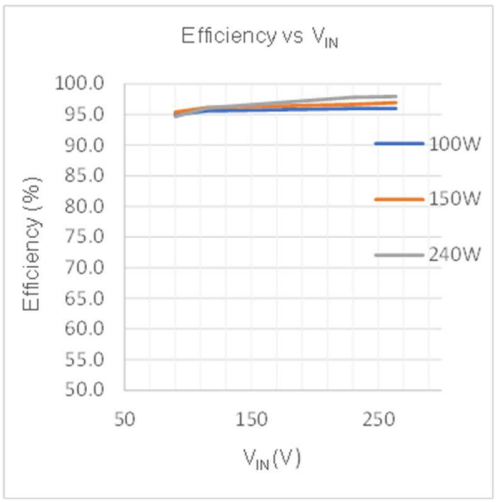


Figure 14. Efficiency (Efficiency vs VIN)

Harmonic Current

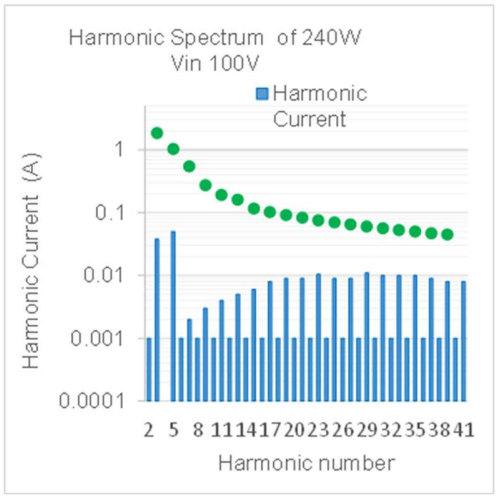


Figure 15. Harmonic Current V_{IN} = 100 V_{ac}

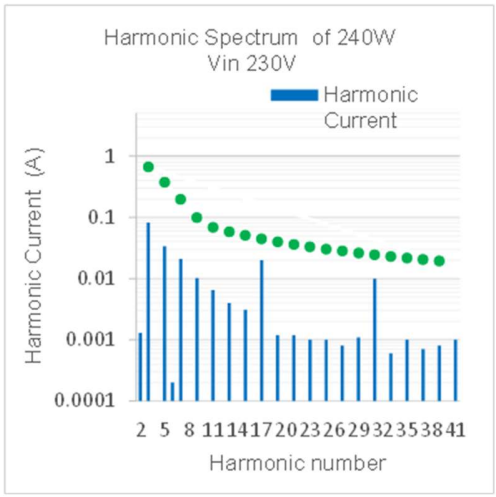


Figure 16. Harmonic Current V_{IN} = 230 V_{ac}

Performance Data – Continued

Input Current

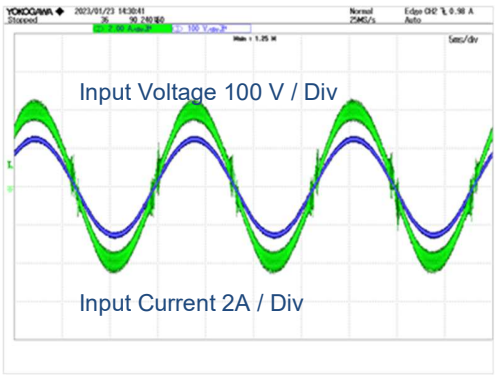


Figure 17. Input Current V_{IN} = 115 V_{ac}, I_{OUT} = 0.6 A

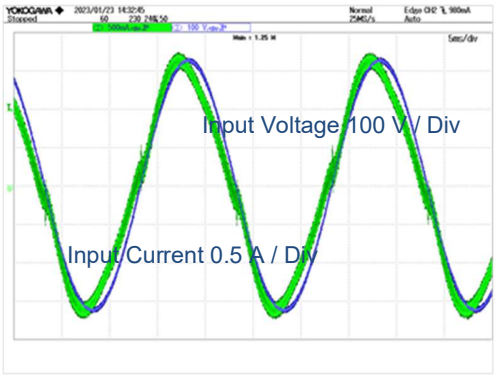


Figure 18. Input Current V_{IN} = 230 V_{ac}, I_{OUT}=0.6 A

V_{DS},I_D WaveForm V_{IN} = 90 V_{ac} Io = 0.6 A

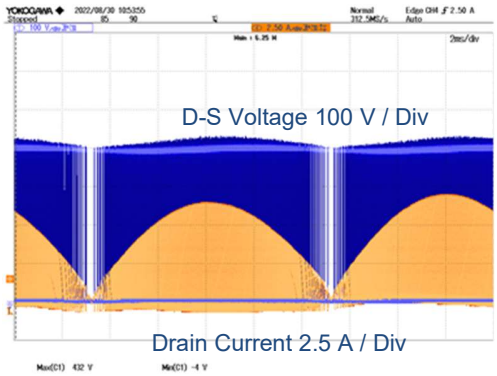


Figure 19. V_{DS},I_D V_{IN} = 90 V_{ac} I_{OUT} = 0.6 A

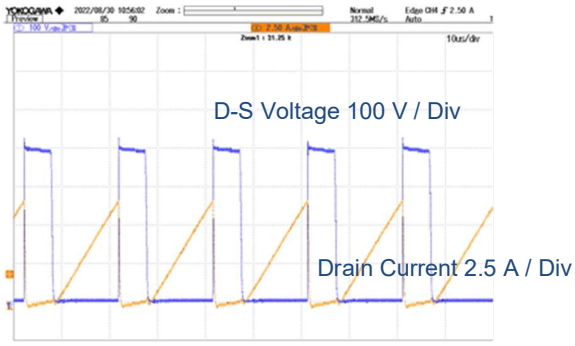


Figure 20. V_{DS},I_D ZOOM

Performance Data – Continued

Hold time

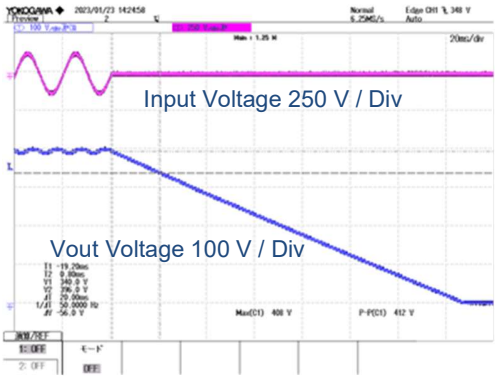


Figure 21. Hold time

Start Up Rload = 650 Ω

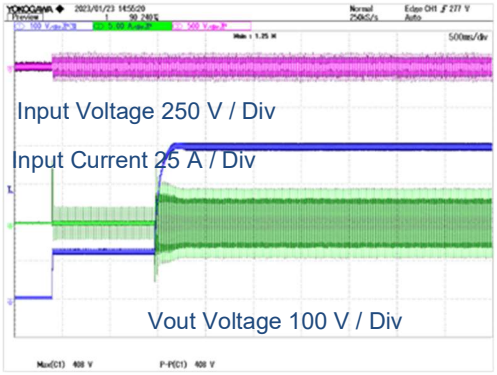


Figure 22. Start Up V_{IN} = 90 V_{ac}

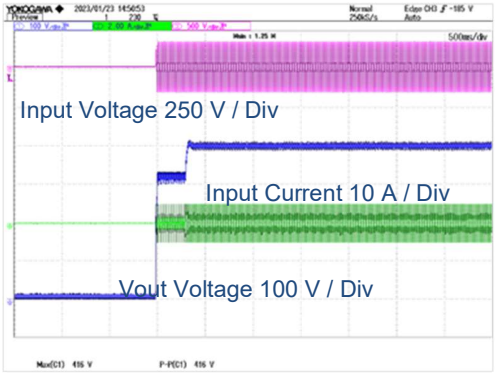


Figure 23. Start Up V_{IN} = 264 V_{ac}

Performance Data - Continued

Load Transient Io = 0.0 A ⇔ 0.6 A

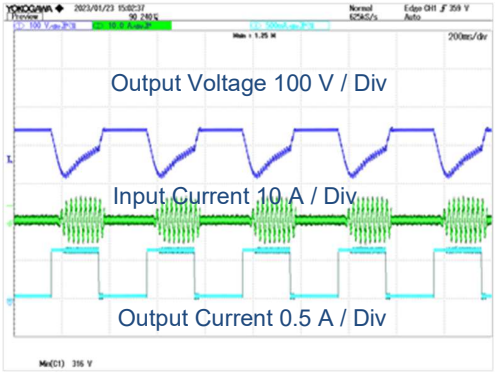


Figure 24. Load Transient V_{IN} = 90 V_{ac}

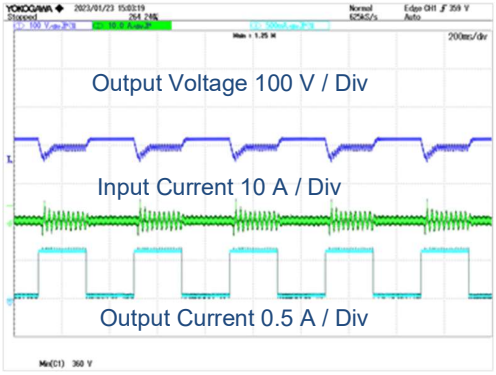


Figure 25. Load Transient V_{IN} = 264 V_{ac}

Output ripple Io = 0.6 A

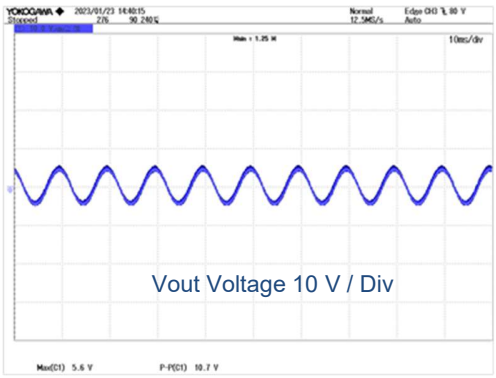


Figure 26. Output ripple V_{IN} = 90 V_{ac}

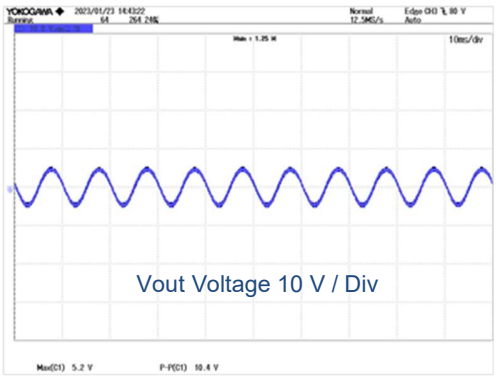


Figure 27. Output ripple V_{IN} = 264 V_{ac}

Performance Data - Continued

・Operating Temperature

Measurement results 30 minutes after power-on.

Table 2. Component surface temperature. (Ta=24°C)

VIN [Vac]	IOUT [A]	D1 [℃]	GaN [℃]	L2	FL1	FL2
90	0.6	74.4	70.0	63.5	64.0	71.7
264	0.6	63.1	48.0	32.2	30.3	33.1

EMI

Conducted Emission: CISPR22 Pub 22 Class B

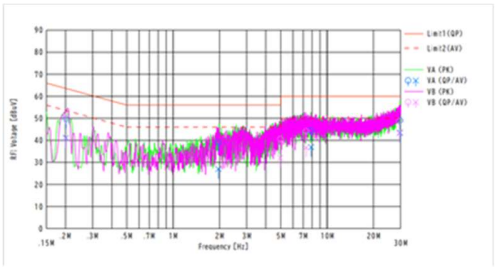


Figure 28. V_{IN} = 100 V_{ac} / 60 Hz, I_{OUT} = 0.6 A

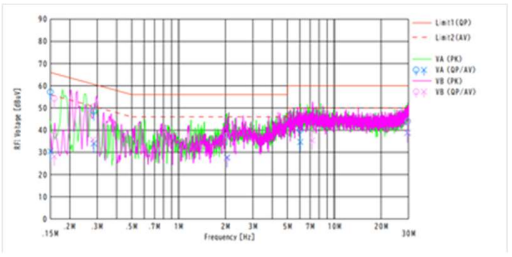


Figure 29. V_{IN} = 230 V_{ac} / 60 Hz, I_{OUT} = 0.6 A

Revision History

Date	Rev.	Changes
24.May.2023	001	New Release